

In re: Edmond *et al.*
Serial No. 09/760,635
Filed: January 16, 2001
Page 2

AMENDMENTS TO THE CLAIMS

This listing of the claims will replace all prior versions of claims in the application.

Listing of Claims:

Claim 1 (Currently Amended) A semiconductor structure for light emitting devices that can emit in the red to ultraviolet portion of the electromagnetic spectrum, said structure comprising:

- a silicon carbide substrate;
- a conductive buffer layer;
- a first n-type cladding layer of $\text{Al}_x\text{In}_y\text{Ga}_{1-x-y}\text{N}$, where $0 \leq x \leq 1$ and $0 \leq y < 1$ and $(x + y) \leq 1$;
- a second n-type cladding layer of $\text{Al}_x\text{In}_y\text{Ga}_{1-x-y}\text{N}$, where $0 \leq x \leq 1$ and $0 \leq y < 1$ and $(x + y) \leq 1$, wherein said second n-type cladding layer is further characterized by the substantial absence of magnesium;
- an active layer of $\text{Al}_x\text{In}_y\text{Ga}_{1-x-y}\text{N}$, where $0 \leq x < 1$ and $0 \leq y \leq 1$ and $(x + y) \leq 1$, wherein said active layer is n-type and is positioned between said first n-type cladding layer and said second n-type cladding layer; and
- a p-type layer of a Group III nitride, wherein said second n-type cladding layer is positioned between said p-type layer and said active layer;

wherein said first n-type cladding layer has a first surface in contact with said conductive buffer layer and a second surface in contact with said active layer;

wherein said first and second n-type cladding layers have respective bandgaps that are each larger than the bandgap of said active layer.

In re: Edmond *et al.*
Serial No. 09/760,635
Filed: January 16, 2001
Page 3

Claim 2 (original) A semiconductor structure according to Claim 1, wherein said active layer has a first surface and a second surface, said first surface of said active layer being in contact with said first n-type cladding layer and said second surface of said active layer being in contact with said second n-type cladding layer.

Claim 3 (original) A semiconductor structure according to Claim 1, wherein said second n-type cladding layer has a first surface and a second surface, said first surface of said second n-type cladding layer being in contact with said active layer, and said second surface of said second n-type cladding layer being in contact with said p-type layer, wherein the composition of said second n-type cladding layer is progressively graded such that the crystal lattice at said first surface of said second n-type cladding layer more closely matches the crystal lattice of said active layer, and the crystal lattice at said second surface of said second n-type cladding layer more closely matches the crystal lattice of said p-type layer.

Claim 4 (original) A semiconductor structure according to Claim 1, wherein said p-type layer is in contact with said second n-type cladding layer, opposite said active layer.

Claim 5 (original) A semiconductor structure according to Claim 1, wherein said second n-type cladding layer consists essentially of $\text{Al}_x\text{Ga}_{1-x}\text{N}$, where $0 < x < 1$.

Claim 6 (original) A semiconductor structure according to Claim 1, wherein said active layer consists essentially of $\text{In}_y\text{Ga}_{1-y}\text{N}$, where $0 < y < 1$.

Claim 7 (original) A semiconductor structure according to Claim 1, wherein said p-type layer is magnesium-doped gallium nitride.

In re: Edmond *et al.*
Serial No. 09/760,635
Filed: January 16, 2001
Page 4

Claim 8 (original) A semiconductor structure according to Claim 7, wherein said second n-type cladding layer is thick enough to deter migration of magnesium from said p-type layer to said active layer, yet thin enough to facilitate recombination in said active layer.

Claim 9 (original) A semiconductor structure according to Claim 1, wherein said p-type layer is indium nitride.

Claim 10 (original) A semiconductor structure according to Claim 1, wherein said p-type layer is $\text{In}_x\text{Ga}_{1-x}\text{N}$, where $0 < x < 1$.

Claim 11 (original) A semiconductor structure according to Claim 1, wherein said p-type layer comprises a superlattice formed from a plurality of Group III nitride layers selected from the group consisting of gallium nitride, indium nitride, and $\text{In}_x\text{Ga}_{1-x}\text{N}$, where $0 < x < 1$.

Claim 12 (original) A semiconductor structure according to Claim 11, wherein said superlattice is formed from alternating layers of two Group III nitride layers selected from the group consisting of gallium nitride, indium nitride, and $\text{In}_x\text{Ga}_{1-x}\text{N}$, where $0 < x < 1$.

Claim 13 (original) A semiconductor structure according to Claim 1, further comprising a third n-type layer of $\text{Al}_x\text{In}_y\text{Ga}_{1-x-y}\text{N}$, where $0 \leq x \leq 1$ and $0 \leq y < 1$ and $(x + y) \leq 1$, wherein said third n-type layer is positioned between said second n-type cladding layer and said p-type layer.

Claim 14 (original) A semiconductor structure according to Claim 13, wherein said third n-type layer has a first surface and a second surface, said first surface of said third n-type layer being in contact with said p-type layer and said second surface of said third n-type layer being in contact with said second n-type cladding layer.

In re: Edmond *et al.*
Serial No. 09/760,635
Filed: January 16, 2001
Page 5

Claim 15 (canceled).

Claim 16 (currently amended) A semiconductor structure according to Claim 1 ~~Claim 15~~, further comprising discrete crystal portions selected from the group consisting of gallium nitride and indium gallium nitride, said discrete crystal portions positioned between said first n-type cladding layer and said ~~silicon-carbide-substrate~~ conductive buffer layer, said discrete crystal portions being present in an amount sufficient to reduce the barrier between said first n-type cladding layer and said ~~silicon-carbide-substrate~~ conductive buffer layer, but less than an amount that would detrimentally affect the function of any resulting light emitting device formed on said silicon carbide substrate.

Claim 17 (canceled).

Claim 18 (Currently Amended) A semiconductor structure according to ~~Claim 17~~ Claim 16, wherein said conductive buffer layer has a first surface and a second surface, said first surface of said conductive buffer layer being in contact with said silicon carbide substrate and said second surface of said conductive buffer layer being in contact with said first n-type cladding layer.

Claim 19 (Currently Amended) A semiconductor structure according to ~~Claim 17~~ Claim 16, wherein said conductive buffer layer consists essentially of aluminum gallium nitride having the formula $Al_xGa_{1-x}N$, where $0 < x < 1$.

In re: Edmond *et al.*
Serial No. 09/760,635
Filed: January 16, 2001
Page 6

Claim 20 (Currently Amended) A semiconductor structure according to ~~Claim 17~~
Claim 16, further comprising an n-type transition layer of a Group III nitride, said transition
layer being positioned between said conductive buffer layer and said first n-type cladding
layer.

Claim 21 (Currently Amended) A semiconductor structure according to ~~Claim 17~~
Claim 16, further comprising discrete crystal portions selected from the group consisting of
gallium nitride and indium gallium nitride, said discrete crystal portions positioned between
said conductive buffer layer and said silicon carbide substrate, said discrete crystal portions
being present in an amount sufficient to reduce the barrier between said conductive buffer
layer and said silicon carbide substrate, but less than an amount that would detrimentally
affect the function of any resulting light emitting device formed on said silicon carbide
substrate.

Claim 22 (Withdrawn) A semiconductor structure for light emitting devices that can
emit in the red to ultraviolet portion of the electromagnetic spectrum, said structure
comprising:

an n-type single crystal silicon carbide substrate of a polytype selected from the group
consisting of 3C, 4H, 6H, and 15R;

a p-type layer formed of at least one Group III nitride selected from the group
consisting of gallium nitride, indium nitride, and $\text{In}_x\text{Ga}_{1-x}\text{N}$, where $0 < x < 1$;

an active layer of $\text{Al}_x\text{In}_y\text{Ga}_{1-x-y}\text{N}$, where $0 \leq x < 1$ and $0 \leq y \leq 1$ and $(x + y) \leq 1$,
wherein said active layer is n-type and is positioned between said silicon carbide substrate and
said p-type layer;

a first n-type cladding layer of $\text{Al}_x\text{In}_y\text{Ga}_{1-x-y}\text{N}$, where $0 \leq x \leq 1$ and $0 \leq y < 1$ and $(x + y) \leq 1$, wherein said first n-type cladding layer is positioned between said silicon carbide
substrate and said active layer;

In re: Edmond *et al.*
Serial No. 09/760,635
Filed: January 16, 2001
Page 7

a second n-type cladding layer of $\text{Al}_x\text{In}_y\text{Ga}_{1-x-y}\text{N}$, where $0 \leq x \leq 1$ and $0 \leq y < 1$ and $(x + y) \leq 1$, wherein said second n-type cladding layer is positioned between said active layer and said p-type layer;

wherein said first and second n-type cladding layers have respective bandgaps that are each larger than the bandgap of said active layer.

Claim 23 (Withdrawn) A semiconductor structure according to Claim 22, wherein said first n-type cladding layer has a first surface and a second surface, said first surface of said first n-type cladding layer being in contact with said silicon carbide substrate, and said second surface of said first n-type cladding layer being in contact with said active layer, wherein the composition of said first n-type cladding layer is progressively graded such that the crystal lattice at said first surface of said first n-type cladding layer more closely matches the crystal lattice of said silicon carbide, and the crystal lattice at said second surface of said first n-type cladding layer more closely matches the crystal lattice of said active layer.

Claim 24 (Withdrawn) A semiconductor structure according to Claim 22, wherein said second n-type cladding layer has a first surface and a second surface, said first surface of said second n-type cladding layer being in contact with said active layer, and said second surface of said second n-type cladding layer being in contact with said p-type layer, wherein the composition of said second n-type cladding layer is progressively graded such that the crystal lattice at said first surface of said second n-type cladding layer more closely matches the crystal lattice of said active layer, and the crystal lattice at said second surface of said second n-type cladding layer more closely matches the crystal lattice of said p-type layer.

Claim 25 (Withdrawn) A semiconductor structure according to Claim 22, wherein said p-type layer is magnesium-doped gallium nitride.

In re: Edmond *et al.*
Serial No. 09/760,635
Filed: January 16, 2001
Page 8

Claim 26 (Withdrawn) A semiconductor structure according to Claim 25, wherein said second n-type cladding layer is thick enough to deter migration of magnesium from said p-type layer to said active layer, yet thin enough to facilitate recombination in the active layer.

Claim 27 (Withdrawn) A semiconductor structure according to Claim 22, wherein said p-type layer comprises a superlattice formed from alternating layers of two Group III nitride layers selected from the group consisting of gallium nitride, indium nitride, and $\text{In}_x\text{Ga}_{1-x}\text{N}$, where $0 < x < 1$.

A
Claim 28 (Withdrawn) A semiconductor structure according to Claim 22, further comprising a third n-type layer of $\text{Al}_x\text{In}_y\text{Ga}_{1-x-y}\text{N}$, where $0 \leq x \leq 1$ and $0 \leq y < 1$ and $(x + y) \leq 1$, wherein said third n-type layer is positioned between said second n-type cladding layer and said p-type layer.

Claim 29 (Withdrawn) A semiconductor structure according to Claim 22, wherein said third n-type layer has a first surface and a second surface, said first surface of said third n-type layer being in contact with said p-type layer and said second surface of said third n-type layer being in contact with said second n-type cladding layer.

Claim 30 (Withdrawn) A semiconductor device according to Claim 22, further comprising a conductive buffer layer consisting essentially of aluminum gallium nitride having the formula $\text{Al}_x\text{Ga}_{1-x}\text{N}$, where $0 \leq x \leq 1$, said conductive buffer layer positioned between said silicon carbide substrate and said first n-type cladding layer.

In re: Edmond *et al.*
Serial No. 09/760,635
Filed: January 16, 2001
Page 9

Claim 31 (Withdrawn) A semiconductor structure according to Claim 30, further comprising an n-type transition layer of a Group III nitride, said transition layer being positioned between said conductive buffer layer and said first n-type cladding layer, and having the same conductivity type as said first n-type cladding layer.

Claim 32 (Withdrawn) A semiconductor structure according to Claim 22, further comprising discrete crystal portions selected from the group consisting of gallium nitride and indium gallium nitride, said discrete crystal portions positioned between said first n-type cladding layer and said silicon carbide substrate, said discrete crystal portions being present in an amount sufficient to reduce the barrier between said first n-type cladding layer and said silicon carbide substrate, but less than an amount that would detrimentally affect the function of any resulting light emitting device formed on said silicon carbide substrate.
